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Particle-Size Selectivity in the Freshwater Bivalve *Elliptio complanata* (Lightfoot)[1]

by

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Abstract. The freshwater bivalve *Elliptio complanata* shows an increase in apparent filtration rate with decreasing particle-size class down to particles between 3.17 and 4.00 μm in diameter, after which filtration rate declines.

INTRODUCTION

FRESHWATER BIVALVE mollusks obtain required energy by filtering sestonic particles from the water column. Workers such as HAUKIOJA & HAKALA (1978) have assumed that differences in growth rates observed among populations of a species reflect differences in the availability of usable sestonic material. PATERSON & CAMERON (1985) partially explained differences in growth rate between two populations of *Anodonta cataracta* on the basis of differences in the abundance of sestonic particles and on differences in the filtration rate of the two populations. HORNBACK *et al.* (1984), in a study of filtration dynamics of *Sphaerium striatinum* for particles of 2.02 μm diameter, concluded that the extent of filtration was insufficient to supply individuals with their energy requirements.

One difficulty with attempting to elucidate the ecology of freshwater bivalves based on some measurement of seston abundance or filtration activity is that for marine suspension-feeding bivalves it has been shown that variations in filtration rate are brought about by such factors as particle size (VAHL, 1973; BAYNE *et al.*, 1977) and abundance (RICE & SMITH, 1958; ALI, 1970; TENORE & DUNSTAN, 1973; FOSTER-SMITH, 1975; WIDDOWS *et al.*, 1979). In addition, various marine species show selectivity for particle size in that the filtration rate calculated as the amount of water pumped per unit time varies with the size of particles used in making the determination. These marine species had maximum filtration rates for particles between about 6 and 10 μm in diameter.

PATERSON (1984) found that the freshwater unionid *Elliptio complanata* (Lightfoot) showed responses similar to those observed in marine species in that filtration rate increased with increasing particle abundance to a maximum and then progressively declined. Filtration rates calculated for varying size classes of particles showed progressive increase as particle size decreased down to a size class of particles of diameters between 4.0 and 5.04 μm, the smallest size class for which filtration rate was measured.

This paper extends the work of PATERSON (1984) to examine possible particle-size selectivity by *Elliptio com-*

Table 1

Particle-size distribution as monitored by the Coulter Counter using a 70-μm aperture.

Channel	Mean geometric volume (μm³)	Minimum volume (μm³)	Minimum diameter (μm)
3	1.481	1.047	1.26
4	2.962	2.094	1.59
5	5.924	4.189	2.00
6	11.85	8.378	2.52
7	23.70	16.76	3.17
8	47.39	33.51	4.00
9	94.78	67.02	5.04
10	189.6	134.0	6.35
11	379.1	268.1	8.00
12	758.3	536.2	10.08
13	1516	1072	12.7
14	3033	2145	16.0
15	6006	4289	20.2
16	12,130	8579	25.4

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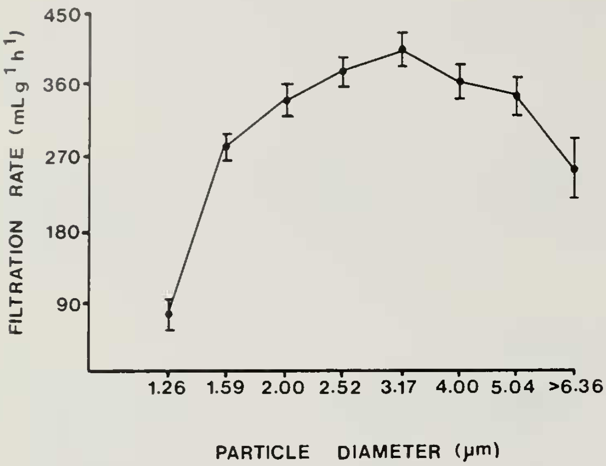

Figure 1

Filtration rate ($mL \cdot g^{-1} \cdot h^{-1}$) of *Elliptio complanata* as determined for different size classes of particles. The particle diameters indicate the smallest diameter found in each particle-size class. Vertical lines represent one standard error about the mean.

planata for particles with diameters less than 4 μm, as such particles might make substantial contributions to the energy requirements of the species if effectively filtered from the water column.

MATERIALS AND METHODS

Specimens of *Elliptio complanata* were collected by dragging in Morice Lake, a relatively old (ca. 1765) polymictic, mesotrophic reservoir located approximately 3 km north of Sackville, New Brunswick, Canada. Experiments were conducted in six plastic containers measuring 27.5 × 23.5 cm and having a depth of 14 cm. Containers were equipped with outlet valves 8.5 cm from the bottom. Six liters of freshly pumped lake water were added to each container. Five specimens of *E. complanata* with a maximum length of 6–7 cm were gently scrubbed and placed into each of four containers. The remaining containers served as controls.

At the initiation of the experiment, 50-mL water samples were removed through the outlet of each container and diluted 1:1 with an electrolyte solution; then, 0.25-

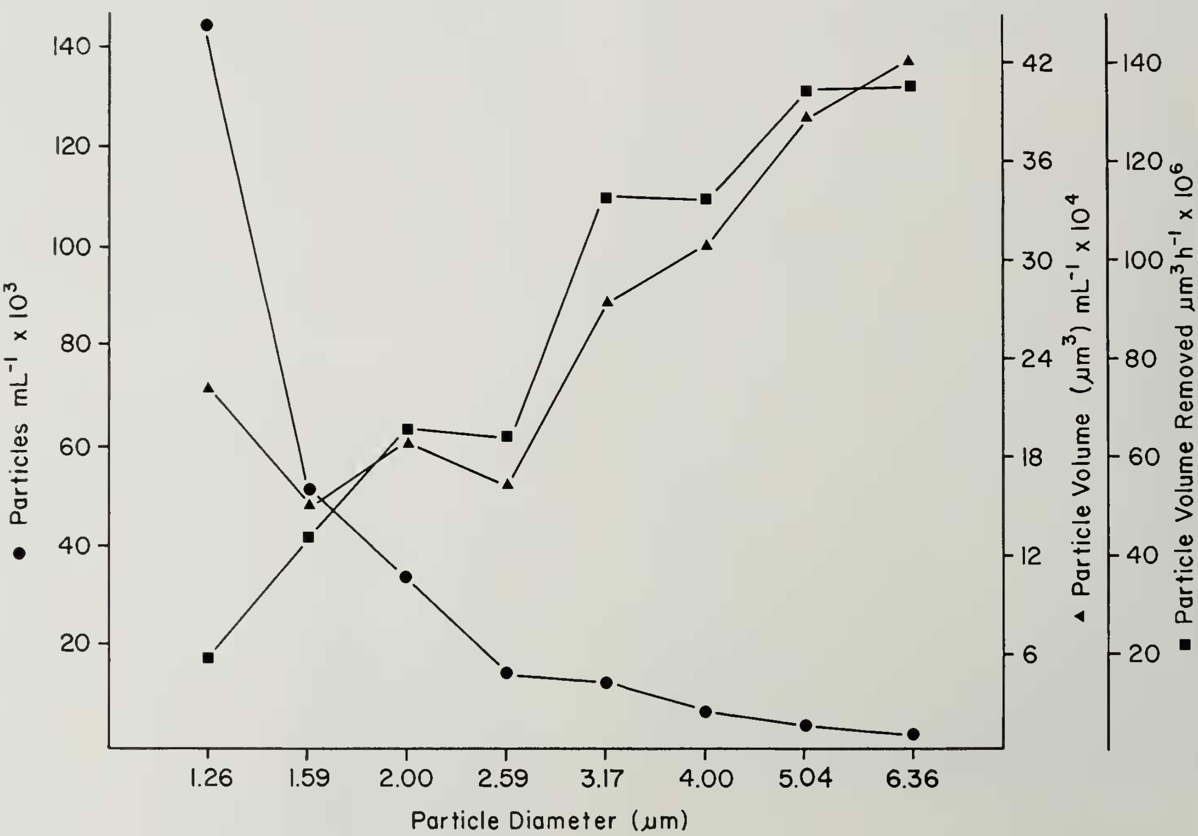

Figure 2

The relationship between the abundance (●) and volume (▲) of particles in the water of Morice Lake, New Brunswick, and the rate of particle volume removal (■) by *Elliptio complanata*.

mL samples were passed through a 70 μm aperture of a model TAII Coulter Counter equipped with a Population Mode. In all cases, triplicate particle counts were taken and averaged. This procedure was then repeated after 2 h. When a particle passes through the aperture, it is counted as well as being assigned to one of 15 channels (channel 3 through channel 16) based on particle size. The mean geometric volume, minimum volume, and minimum diameter of the particles measured by each channel when a 70 μm aperture is used are given in Table 1. Because particle counts in channels 10 to 16 were too low to accurately determine filtration rate, these particle counts were pooled. The background count due to the electrolyte solution was determined and suitable corrections made. Each experiment consisted of measuring changes in particle abundance in four test containers each containing five *Elliptio complanata* and two control containers. This experimental procedure was repeated nine times during the summer months at experimental temperatures that ranged from 19.0 to 21.0°C.

At the end of an experiment, the length of each bivalve in a container was determined to the nearest 0.5 mm using calipers and filtration rate ($mL \cdot g^{-1} \cdot h^{-1}$) determined as in PATERSON (1984).

RESULTS AND DISCUSSION

Average filtration rate ($mL \cdot g^{-1} \cdot h^{-1}$) varied significantly (ANOVA $F = 5.46$; df 7,64; $P < 0.001$) over the range of particle sizes, with a maximum rate observed for channel 7 which contains particles with diameters between 3.17 and 4.00 μm (Figure 1). These data extend the findings of PATERSON (1984) to show that, in *Elliptio complanata,* filtration rate increases with decreasing particle size down to a minimum diameter of about 3.17 μm after which filtration rate progressively declines with further decreases in particle size.

The filtration rate calculated for any particle size is a measure of the amount of water that would need to be pumped across the gills if particle removal were 100% efficient. The results presented in Figure 1 indicate that efficiency of particle removal is greatest for particles in the size class 3.17–4.00 μm. This then raises the question of the potential significance of this peak value for removal efficiency when *Elliptio complanata* is filtering a natural array of particles in lake water. When the particle volume per milliliter for each channel is multiplied by the filtration rate observed for the particles in that channel, the total volume of particles removed per hour increases with increased size (Figure 2). To *Elliptio complanata* filtering Morice Lake water, there is no readily apparent advantage to having a maximum efficiency of removal for particles in the 3.17–4.00 μm size class. However, the Coulter Counter does not distinguish between organic and inorganic particles. In addition, no information is available on possible relationships among efficiency of removal, ingestion, and energy assimilation for different sized particles.

It is apparent, however, that any attempts to relate such factors as growth rate or abundance to sestonic abundance, or to measure potential energy intake, must be undertaken within a framework that takes into account both particle abundance and particle size.

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